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AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A method for compensating for time dispersion in a receiver of a wireless system that has a plurality of transmit antennas and a plurality of receive antennas, the method comprising the steps of:

receiving samples for each receive antenna;

determining a joint equalizer solution using channel information for at least one pairing of at least one of said transmit antennas and said receive antennas and said received samples of at least two of said antennas; and

applying said determined joint equalizer solution to said received samples from at least one of said receive antennas to develop equalized samples.

2. (Original) The invention as defined in claim 1 wherein said joint equalizer solution is a joint minimum mean square error (MMSE) solution.

3. (Original) The invention as defined in claim 1 further comprising the step of estimating a channel for at least one pairing of at least one of said transmit antennas and said receive antennas.

4. (Original) The invention as defined in claim 1 wherein in said determining step determining said joint equalizer solution is determined using channel information for at least one pairing of at least one of said transmit antennas and all of said receive antennas.

5. (Original) The invention as defined in claim 1 wherein said step of determining a joint equalizer solution is performed at least partly in the discrete frequency domain.

6. (Original) The invention as defined in claim 1 wherein said step of applying said determined equalizer solution is performed in the time domain.

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    7. (Original) The invention as defined in claim 1 said step of applying said determined joint equalizer solution is performed in the frequency domain.

    8. (Original) The invention as defined in claim 1 further comprising the step of despreading said equalized samples.

    9. (Previously presented) The invention as defined in claim 1 wherein at least two of said transmit antennas transmit at different rates.

    10. (Previously presented) The invention as defined in claim 1 wherein at least two of said transmit antennas transmit using different transmit constellations.

    11. (Currently amended) The invention as defined in claim 1 further comprising the step of performing soft bit mapping using a version of said equalized samples.

    12. (Original) The invention as defined in claim 11 wherein said version of said equalized samples are despread samples.

    13. (Original) The invention as defined in claim 11 wherein said step of performing soft mapping further comprises the step of spatial whitening said version of said equalized samples.

    14. (Original) The invention as defined in claim 11 wherein said step of performing soft mapping further comprises the step of performing a posteriori probability (APP) metric processing on said version of said equalized samples.

    15. (Original) The invention as defined in claim 1 wherein said determining step is performed multiple times, once for each one of said transmit antennas.

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16. (Original) The invention as defined in claim 1 wherein said determining and applying steps are iterated multiple times over a symbol period, one iteration for each one of said transmit antennas, and said method further comprises, for each iteration, the steps of:

generating a representation of signals that would have arrived had a particular symbol for a currently being processed transmit antenna had been transmitted; and

subtracting said representation from said samples received for each receive antenna.

17. (Original) The invention as defined in claim 1 wherein said joint equalizer solution is one from the group consisting of: a joint least mean square (LMS) solution, a joint recursive least squares (RLS) solution, or a joint minimum intersymbol interference (ISI) subject to an anchor condition solution.

18. (Currently amended) A receiver for use in a multiple-input multiple-output (MIMO) system in which a plurality of signal detectors receive signals transmitted by a plurality of signal sources, said receiver comprising:

a joint equalizer that develops a joint equalizer solution using channel information for at least one pairing of said at least one of said signal sources and said signal detectors and received samples of at least two of said signal detectors and supplies as an output a signal that includes at least said equalizer solution applied to a signal received by at least one of said signal detectors; and

a soft bit mapper for developing soft bits from said joint equalizer output.

19. (Original) The invention as defined in claim 18 wherein said joint equalizer solution is a joint minimum mean square error (MMSE) equalizer solution

20. (Original) The invention as defined in claim 18 wherein said soft bit mapper further comprises an a posteriori probability (APP) metric processor.

21. (Original) The invention as defined in claim 18 wherein said soft bit mapper further comprises a spatial whitening unit.

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22. (Original) The invention as defined in claim 18 further comprising a despreader interposed between said joint equalizer and said soft bit mapper.

23. (Original) The invention as defined in claim 18 wherein at least two of said transmit sources transmits signals at different rates.

24. (Original) The invention as defined in claim 18 wherein at least two of said transmit sources transmits signals using different transmit constellations.

25. (Original) The invention as defined in claim 18 further comprising:
   a space time regenerator coupled to said joint equalizer; and
   a buffer-subtractor coupled between said signal detectors and said joint equalizer and between said space time regenerator and said joint equalizer.

26. (Original) The invention as defined in claim 25 further comprising a front end processor coupled to said buffer-subtractor.

27. (Original) The invention as defined in claim 18 further comprising
   a soft bit mapper coupled to said joint equalizer;
   an error correction decoder coupled to said soft bit mapper;
   a space time regenerator coupled to said error correction decoder; and
   a buffer-subtractor coupled between said signal detectors and said joint equalizer and between said space time regenerator and said joint equalizer.

28. (Original) The invention as defined in claim 27 further comprising a front end processor coupled to said buffer-subtractor.

29. (Original) The invention as defined in claim 18 further comprising an order controller for determining an order in which signals from said signal detectors will be processed by said joint equalizer.

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1   30. (Previously presented) The invention as defined in claim 19 wherein said join

2   equalizer further comprises:

3   a first plurality of fast Fourier transform processors, each of said fast Fourier

4   transform processors being coupled to receive a respective input corresponding to a signal

5   received by one of said signal detectors and supplying as an output a discrete frequency

6   domain representation thereof;

7   a plurality of channel estimation units each of which is coupled to receive a

8   respective input corresponding to a signal received by one of said signal detectors which

9   develops a channel estimate for each channel between each respective signal source and

10   each respective signal detector;

11   a second plurality of fast Fourier transform processors, each of said second

12   plurality of fast Fourier transform processors coupled to receive a respective input

13   corresponding to a channel estimate for a respective one of said channels between said

14   signal sources and said signal detectors and supplying as an output a discrete frequency

15   domain representation thereof;

16   an MMSE detection per frequency bin processor coupled to receive as inputs said

17   outputs from said first plurality of fast Fourier transform processors and from said second

18   plurality of fast Fourier transform processors to produce a discrete frequency domain

19   representation of an application of said joint minimum mean square error (MMSE)

20   equalizer solution to said signals received by each of said signal detectors; and

21   a plurality of inverse fast Fourier transform processors which convert said discrete

22   frequency domain representation of an application of said joint minimum mean square

23   error (MMSE) equalizer solution to the time domain.

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1 31. (Previously presented) The invention as defined in claim 30 wherein M is the
2 number of signal sources and N is the number of signal detectors, and
3 wherein said MMSE detection per frequency processor performs the equalization
4 in the frequency domain by computing

5
$$\mathbf{z}(\omega) = \left(\mathbf{H}(\omega)^H \mathbf{H}(\omega) + \sigma^2 \mathbf{I} \right)^{-1} \mathbf{H}(\omega)^H \mathbf{r}(\omega)$$

6 where

7
$$\mathbf{H}(\omega) = \begin{bmatrix} h_{1,1}(\omega) & \cdots & h_{1,M}(\omega) \\ \vdots & \ddots & \vdots \\ h_{N,1}(\omega) & \cdots & h_{N,M}(\omega) \end{bmatrix}$$

8

9
$$\mathbf{r}(\omega) = \begin{bmatrix} r_1(\omega) \\ r_2(\omega) \\ \vdots \\ r_N(\omega) \end{bmatrix}$$

10
$$\sigma^2 = \frac{\sigma_n^2}{\sigma_x^2}$$

11 σ_n^2 is the background noise plus interference power,
12 σ_x^2 is the sum of the power received by all said signal detectors from all of said
13 signal sources,
14 each r(ω) is said output of a one of said first plurality of fast Fourier transform
15 processors,
16 each h(ω) is said output of a one of said second plurality of fast Fourier transform
17 processors,
18 I is the identity matrix,
19 X^H means the Hermitian transpose of X, which is the complex conjugate
20 transpose of the vector or matrix X, and
21 z(ω) is the equalized output vector in the frequency domain for frequency ω.

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1   32. (Previously presented) The invention as defined in claim 19 wherein said joint,

2   equalizer further comprises:

3   a plurality of channel estimation units each of which coupled to receive a

4   respective input corresponding to a signal received by one of said signal detectors which

5   develops a channel estimate for each channel between each respective signal source and

6   each respective signal detector;

7   a plurality of fast Fourier transform processors, each of said plurality of fast

8   Fourier transform processors being coupled to receive a respective input corresponding to

9   a channel estimate for a respective one of said channels between said signal sources and

10   said signal detectors and supplying as an output a discrete frequency domain

11   representation thereof;

12   an MMSE tap weight calculator coupled to receive as inputs said outputs from

13   said plurality of fast Fourier transform processors to produce a discrete frequency domain

14   representation of a joint minimum mean square error (MMSE) equalizer solution to said

15   signals received by each of said signal detectors;

16   a plurality of inverse fast Fourier transform processors which convert said discrete

17   frequency domain representation of a joint minimum mean square error (MMSE)

18   equalizer solution to matrices of filter coefficients in the time domain; and

19   a matrix finite impulse response (FIR) filter coupled to apply said matrices of

20   filter coefficients in the time domain to said signals received by said signal detectors.

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1   33. (Previously presented) The invention as defined in claim 32 wherein M is the
2   number of signal sources and N is the number of signal detectors, and wherein said
3   MMSE equalizer solution is developed by computing:

4
$$S(\omega) = \left(H(\omega)^H H(\omega) + \sigma^2 I\right)^{-1} H(\omega)^H$$

5   where

6
$$H(\omega) = \begin{bmatrix} h_{1,1}(\omega) & \cdots & h_{1,M}(\omega) \\ \vdots & \ddots & \vdots \\ h_{N,1}(\omega) & \cdots & h_{N,M}(\omega) \end{bmatrix}$$

7

8
$$\sigma^2 = \frac{\sigma_n^2}{\sigma_x^2}$$

9   σ_n^2 is the background noise plus interference power,

10   σ_x^2 is the sum of the power received by all said signal detectors from all of said

11   signal sources,

12   each $h(\omega)$ is said output of a one of said plurality of fast Fourier transform

13   processors,

14   I is the identity matrix,

15   X^H means the Hermitian transpose of X, which is the complex conjugate

16   transpose of the vector or matrix X, and

17       $S(\omega)$ is a frequency domain matrix representing the equalization for frequency ω.

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34. (Original) The invention as defined in claim 33 wherein said matrix FIR filter applies said matrices of filter coefficients in the time domain to said signals received by said signal detectors by computing

$$y(k) = \sum_{j=0}^{F-1} S_j r(k-j)$$

where $y(k)$ is the vector output at time k, y having one component for each of said signal sources,

S_j is a MxN filter matrix for delay j, which is the inverse Fourier transform of $S(\omega)$,

$r(k)$ is a vector of received samples at time k, and

F is the number of samples taken for each fast Fourier transform by each of said plurality of fast Fourier transform processors.

35. (Original) The invention as defined in claim 18 wherein said MIMO system is a wireless system, said signal sources are transmit antennas and said detectors are antennas of said receiver.

36. (Original) The invention as defined in claim 18 wherein said joint equalizer develops said joint equalizer solution as a function of estimates of the channels between each of said signal sources and said signal detectors.

37. (Previously presented) The invention as defined in claim 36 18 wherein said joint equalizer develops and applies said joint equalizer solution in a time domain.

38. (Previously presented) The invention as defined in claim 36 18 wherein said joint equalizer develops and applies said joint equalizer solution in a frequency domain.

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1   39. (Previously presented) The invention as defined in claim ~~36~~ 19 wherein said
2 joint equalizer develops and applies said joint equalizer solution in a discrete frequency
3 domain and applies said joint minimum mean square error (MMSE) equalizer solution in
4 a time domain.

1   40. (Previously presented) The invention as defined in claim 19 wherein said joint
2 equalizer develops said joint minimum mean square error (MMSE) equalizer solution by
3 computing

4
$$W = A \, \Gamma(H)^{H} \left(\Gamma(H)^{H} \, \Gamma(H) + \frac{\sigma_n^2}{\sigma_x^2} R_{pp} \right)^{-1}$$

5 where

6 $\Gamma(H)$ is a MIMO convolution operator,

7 X^{H} means the Hermitian transpose of X, which is the complex conjugate

8 transpose of the vector or matrix X,

9 A is a delay matrix ,

10 σ_n^2 is the background noise plus interference power,

11 σ_x^2 is the sum of the power received by all said signal detectors from all of said

12 signal sources,

13 noise covariance R_{pp},

14 and said joint equalizer applies said joint minimum mean square error (MMSE)

15 equalizer solution by computing

16 $y(k) = Wr(k)$

17 where $r(k)$ is a vector of received samples at time k, and

18 $y(k)$ is the vector output at time k representing the application of said joint

19 minimum mean square error (MMSE) equalizer to said vector of received samples at time

20 k.

1   41. (Original) The invention as defined in claim 18 wherein said joint equalizer
2 solution is one from the group consisting of: a joint least mean square (LMS) solution, a
3 joint recursive least squares (RLS) solution, or a joint minimum intersymbol interference
4 (ISI) subject to an anchor condition solution.

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1   42. (Currently amended) A receiver for use in a multiple-input multiple-output

2   (MIMO) system in which a plurality of receive antennas receive signals transmitted by a

3   plurality of transmit antennas, said receiver comprising:

4   means for (i) developing a joint equalizer solution using channel information for

5   at least one pairing of at least one of said transmit antennas and said receive antennas <u>and</u>

6   <u>said received samples of at least two of said receive antennas</u> and (ii) supplying as an

7   output a signal that includes at least said joint equalizer solution applied to a signal

8   received by at least one of said receive antennas; and

9   means for developing soft bits from said output signal.

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